Cisco SFS InfiniBand Host Drivers User Guide for Linux

Release 3.2.0
June 2007

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Text Part Number: OL-12309-01

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User Guide for Linux

CONTENTS

Preface

This preface describes who should read the *Cisco SFS InfiniBand Host Drivers User Guide for Linux*, how it is organized, and its document conventions. It includes the following sections:

Audience

The intended audience is the administrator responsible for installing, configuring, and managing host drivers and host card adapters. This administrator should have experience administering similar networking or storage equipment.

Organization

This publication is organized as follows:

Chapter	Title	Description
Chapter 1	About Host Drivers	Describes the Cisco commercial host driver.
Chapter 2	Installing Host Drivers	Describes the installation of host drivers.
Chapter 3	IP over IB Protocol	Describes how to configure IPoIB to run IP traffic over an IB network.
Chapter 4	SCSI RDMA Protocol	Describes how to configure SRP.
Chapter 5	Sockets Direct Protocol	Describes how to configure and run SDP.
Chapter 6	uDAPL	Describes how to build and configure uDAPL.
Chapter 7	MVAPICH MPI	Describes the setup and configuration information for MVAPICH MPI.

Chapter	Title	Description
Chapter 8	HCA Utilities and Diagnostics	Describes the fundamental HCA utilities and diagnostics.
Appendix A	Acronyms and Abbreviations	Defines the acronyms and abbreviations that are used in this publication.

Conventions

This document uses the following conventions:

Convention	Description
boldface font	Commands, command options, and keywords are in **boldface**. Bold text indicates Chassis Manager elements or text that you must enter as-is.
italic font	Arguments in commands for which you supply values are in *italics*. Italics not used in commands indicate emphasis.
Menu1 > Menu2 > Item…	Series indicate a pop-up menu sequence to open a form or execute a desired function.
[ ]	Elements in square brackets are optional.
{ x | y | z }	Alternative keywords are grouped in braces and separated by vertical bars. Braces can also be used to group keywords and/or arguments; for example, {**interface** *interface* **type**}.
[x | y | z]	Optional alternative keywords are grouped in brackets and separated by vertical bars.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string will include the quotation marks.
`screen` font	Terminal sessions and information the system displays are in `screen` font.
`boldface screen` font	Information you must enter is in **`boldface screen`** font.
`italic screen` font	Arguments for which you supply values are in *`italic screen`* font.
^	The symbol ^ represents the key labeled Control—for example, the key combination ^D in a screen display means hold down the Control key while you press the D key.
< >	Nonprinting characters, such as passwords are in angle brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Notes use the following convention:

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

Cautions use the following convention:

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Root and Non-root Conventions in Examples

This document uses the following conventions to signify root and non-root accounts:

Convention	Description
`host1#` `host2#`	When this prompt appears in an example, it indicates that you are in a root account.
`host1$` `host2$`	When this prompt appears in an example, it indicates that you are in a non-root account.

Related Documentation

For additional information related to the Cisco SFS IB host drivers, see the following documents:

- *Cisco InfiniBand Host Channel Adapter Hardware Installation Guide*
- *Release Notes for Linux Host Drivers Release 3.2.0*
- *Release Notes for Cisco OFED, Release 1.1*
- *Cisco OpenFabrics Enterprise Distribution InfiniBand Host Drivers User Guide for Linux*
- *Cisco SFS Product Family Element Manager User Guide*
- *Cisco SFS InfiniBand Fibre Channel Gateway User Guide*

Obtaining Documentation, Obtaining Support, and Security Guidelines

For information on obtaining documentation, obtaining support, providing documentation feedback, security guidelines, and also recommended aliases and general Cisco documents, see the monthly *What's New* in Cisco Product Documentation, which also lists all new and revised Cisco technical documentation, at:

http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html

CHAPTER 1

About Host Drivers

This chapter describes host drivers and includes the following sections:

Note For expansions of acronyms and abbreviations used in this publication, see Appendix A, "Acronyms and Abbreviations."

Introduction

The Cisco IB HCA offers high-performance 10-Gbps and 20-Gbps IB connectivity to PCI-X and PCI-Express-based servers. As an integral part of the Cisco SFS solution, the Cisco IB HCA enables you to create a unified fabric for consolidating clustering, networking, and storage communications.

After you physically install the HCA in the server, install the drivers to run IB-capable protocols. HCAs support the following protocols in the Linux environment:

- IPoIB
- SRP
- SDP

HCAs support the following APIs in the Linux environment:

- MVAPICH MPI
- uDAPL API
- Intel MPI
- HP MPI

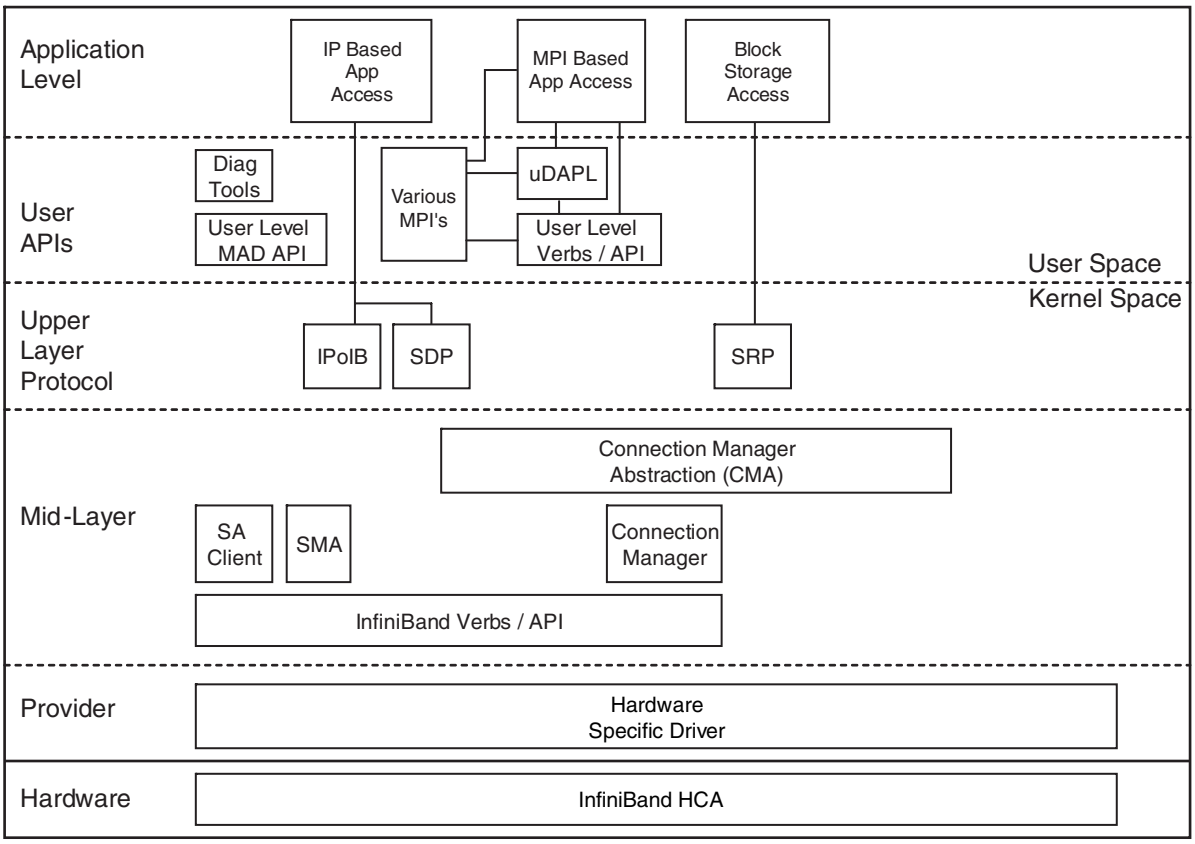
Host drivers also provide utilities to help you configure and verify your HCA. These utilities provide upgrade and diagnostic features.

Note See the "Root and Non-root Conventions in Examples" section on page ix for details about the significance of prompts used in the examples in this chapter.

Architecture

Figure 1-1 displays the software architecture of the protocols and APIs that HCAs support. The figure displays ULPs and APIs in relation to other IB software elements.

Figure 1-1 HCA Supported Protocols and API Architecture



IPoIB	IP over InfiniBand	MPI	Message Passing Interface	MAD	Management Datagram
SDP	Sockets Direct Protocol	UDAPL	User Direct Access Programming Lib	SMA	Subnet Manager Agent
SRP	SCSI RDMA Protocol (Initiator)	SA	Subnet Administrator	HCA	Host Channel Adapter

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Supported Protocols

This section describes the supported protocols and includes the following topics:

Protocol here refers to software in the networking layer in kernel space.

IPoIB

The IPoIB protocol passes IP traffic over the IB network. Configuring IPoIB requires similar steps to configuring IP on an Ethernet network. SDP relies on IPoIB to resolve IP addresses. (See the "SDP" section on page 1-3.)

To configure IPoIB, you assign an IP address and subnet mask to each IB port. IPoIB automatically adds IB interface names to the IP network configuration. To configure IPoIB, see Chapter 3, "IP over IB Protocol."

SRP

SRP runs SCSI commands across RDMA-capable networks so that IB hosts can communicate with Fibre Channel storage devices and IB-attached storage devices. SRP requires an SFS with a Fibre Channel gateway to connect the host to Fibre Channel storage. In conjunction with an SFS, SRP disguises IB-attached hosts as Fibre Channel-attached hosts. The topology transparency feature lets Fibre Channel storage communicate seamlessly with IB-attached hosts (known as SRP hosts). For configuration instructions, see Chapter 4, "SCSI RDMA Protocol."

SDP

SDP is an IB-specific upper- layer protocol. It defines a standard wire protocol to support stream sockets networking over IB. SDP enables sockets-based applications to take advantage of the enhanced performance features provided by IB and achieves lower latency and higher bandwidth than IPoIB running sockets-based applications. It provides a high-performance, data transfer protocol for stream-socket networking over an IB fabric. You can configure the driver to automatically translate TCP to SDP based on a source IP, a destination, or an application name. For configuration instructions, see Chapter 5, "Sockets Direct Protocol."

Supported APIs

This section describes the supported APIs and includes the following topics:

- MVAPICH MPI
- uDAPL
- Intel MPI
- HP MPI

API refers to software in the networking layer in user space.

MVAPICH MPI

MPI is a standard library functionality in C, C++, and Fortran that can be used to implement a message-passing program. MPI allows the coordination of a program running as multiple processes in a distributed memory environment. This document includes setup and configuration information for MVAPICH MPI. For more information, see Chapter 7, "MVAPICH MPI."

uDAPL

uDAPL defines a single set of user-level APIs for all RDMA-capable transports. The uDAPL mission is to define a transport-independent and platform-standard set of APIs that exploits RDMA capabilities such as those present in IB. For more information, see Chapter 6, "uDAPL."

Intel MPI

Cisco tests and supports the SFS IB host drivers with Intel MPI. The Intel MPI implementation is available for separate purchase from Intel. For more information, visit the following URL:

http://www.intel.com/go/mpi

HP MPI

Cisco tests and supports the SFS IB host drivers with HP MPI for Linux. The HP MPI implementation is available for separate purchase from Hewlett Packard. For more information, visit the following URL:

http://www.hp.com/go/mpi

HCA Utilities and Diagnostics

The HCA utilities provide basic tools to view HCA attributes and run preliminary troubleshooting tasks. For more information, see Chapter 8, "HCA Utilities and Diagnostics."

CHAPTER 2

Installing Host Drivers

The chapter includes the following sections:

Note See the "Root and Non-root Conventions in Examples" section on page ix for details about the significance of prompts used in the examples in this chapter.

Introduction

The Cisco Linux IB driver is delivered as an ISO image. The ISO image contains the binary RPMs for selected Linux distributions. The Cisco Linux IB drivers distribution contains an installation script called tsinstall. The install script performs the necessary steps to accomplish the following:

- Discover the currently installed kernel
- Uninstall any IB stacks that are part of the standard operating system distribution
- Install the Cisco binary RPMs if they are available for the current kernel
- Identify the currently installed IB HCA and perform the required firmware updates

Note For specific details about which binary RPMs are included and which standard Linux distributions and kernels are currently supported, see the *Release Notes for Linux Host Drivers Release 3.2.0*.

Contents of ISO Image

The ISO image contains the following directories and files:

- docs/

  This directory contains the related documents.

- tsinstall

  This is the installation script.

- redhat/

  This directory contains the binary RPMs for Red Hat Enterprise Linux.

- suse/

  This directory contains the binary RPMs for SUSE Linux Enterprise Server.

Installing Host Drivers from an ISO Image

See the *Cisco InfiniBand Host Channel Adapter Hardware Installation Guide* to correctly install HCAs. To install host drivers from an ISO image, perform the following steps:

Note If you upgrade your Linux kernel after installing these host drivers, you need to reinstall the host drivers.

Step 1 Verify that the system has a viable HCA installed by ensuring that you can see the InfiniHost entries in the display.

The following example shows that the installed HCA is viable:

```
host1# lspci -v | grep Mellanox
06:01.0 PCI bridge: Mellanox Technologies MT23108 PCI Bridge (rev a0) (prog-if 00 [Normal
decode])
07:00.0 InfiniBand: Mellanox Technologies MT23108 InfiniHost (rev a0)
        Subsystem: Mellanox Technologies MT23108 InfiniHost
```

Step 2 Download an ISO image, and copy it to your network.

You can download an ISO image from http://www.cisco.com/cgi-bin/tablebuild.pl/sfs-linux

Step 3 Use the md5sum utility to confirm the file integrity of your ISO image.

Step 4 Install drivers from an ISO image on your network.

The following example shows how to install host drivers from an ISO image:

```
host1# mount -o ro,loop topspin-host-3.2.0-136.iso /mnt
host1# /mnt/tsinstall

The following kernels are installed, but do not have drivers available:
  2.6.9-34.EL.x86_64

The following installed packages are out of date and will be upgraded:
  topspin-ib-rhel4-3.2.0-118.x86_64
  topspin-ib-mpi-rhel4-3.2.0-118.x86_64
  topspin-ib-mod-rhel4-2.6.9-34.ELsmp-3.2.0-118.x86_64

The following packages will be installed:
  topspin-ib-rhel4-3.2.0-136.x86_64 (libraries, binaries, etc)
```

```
  topspin-ib-mpi-rhel4-3.2.0-136.x86_64 (MPI libraries, source code, docs, etc)
  topspin-ib-mod-rhel4-2.6.9-34.ELsmp-3.2.0-136.x86_64 (kernel modules)

installing 100% ###################################################################

Upgrading HCA 0 HCA.LionMini.A0 to firmware build 3.2.0.136
New Node  GUID = 0005ad0000200848
New Port1 GUID = 0005ad0000200849
New Port2 GUID = 0005ad000020084a
Programming HCA firmware... Flash Image Size = 355076
Flashing - EFFFFFFFEPPPPPPPEWWWWWWWEWWWWWWWEWWWWVVVVVVVVVVVVVVVVVVVVVVVVVVVV
Flash verify passed!
```

Step 5 Run a test to verify whether or not the IB link is established between the respective host and the IB switch.

The following example shows a test run that verifies an established IB link:

```
host1# /usr/local/topspin/sbin/hca_self_test
---- Performing InfiniBand HCA Self Test ----
Number of HCAs Detected ................ 1
PCI Device Check ....................... PASS
Kernel Arch ............................ x86_64
Host Driver Version .................... rhel4-2.6.9-34.ELsmp-3.2.0-136
Host Driver RPM Check .................. PASS
HCA Type of HCA #0 ..................... LionMini
HCA Firmware on HCA #0 ................. v5.2.000 build 3.2.0.136 HCA.LionMini.A0
HCA Firmware Check on HCA #0 ........... PASS
Host Driver Initialization ............. PASS
Number of HCA Ports Active ............. 2
Port State of Port #0 on HCA #0 ........ UP 4X
Port State of Port #1 on HCA #0 ........ UP 4X
Error Counter Check on HCA #0 .......... PASS
Kernel Syslog Check .................... PASS
Node GUID .............................. 00:05:ad:00:00:20:08:48
------------------ DONE ---------------------
```

The HCA test script, as shown in the example above, checks for the HCA firmware version, verifies that proper kernel modules are loaded on the IP drivers, shows the state of the HCA ports, shows the counters that are associated with each IB port, and indicates whether or not there are any error messages in the host operating system log files.

Note To troubleshoot the results of this test, see Chapter 8, "HCA Utilities and Diagnostics."

Uninstalling Host Drivers from an ISO Image

The following example shows how to uninstall a host driver from a device:

```
host1# rpm -e `rpm -qa | grep topspin`
```

CHAPTER 3

IP over IB Protocol

This chapter describes IP over IB protocol and includes the following sections:

Note See the "Root and Non-root Conventions in Examples" section on page ix for details about the significance of prompts used in the examples in this chapter.

Introduction

Configuring IPoIB requires that you follow similar steps to the steps used for configuring IP on an Ethernet network. When you configure IPoIB, you assign an IP address and a subnet mask to each HCA port. The first HCA port on the first HCA in the host is the ib0 interface, the second port is ib1, and so on.

Note To enable these IPoIB settings across reboots, you must explicitly add these settings to the networking interface startup configuration file. For a sample configuration file, see the "Sample Startup Configuration File" section on page 3-8.

See your Linux distribution documentation for additional information about configuring IP addresses.

Manually Configuring IPoIB for Default IB Partition

To manually configure IPoIB for the default IB partition, perform the following steps:

Step 1 Log in to your Linux host.

Step 2 To configure the interface, enter the **ifconfig** command with the following items:

- The appropriate IB interface (**ib0** or **ib1** on a host with one HCA)
- The IP address that you want to assign to the interface
- The **netmask** keyword
- The subnet mask that you want to assign to the interface

The following example shows how to configure an IB interface:

```
host1# ifconfig ib0 192.168.0.1 netmask 255.255.252.0
```

Step 3 (Optional) Verify the configuration by entering the **ifconfig** command with the appropriate port identifier *ib#* argument.

The following example shows how to verify the configuration:

```
host1# ifconfig ib0
ib0       Link encap:Ethernet HWaddr F8:79:D1:23:9A:2B
          inet addr:192.168.0.1  Bcast:192.168.0.255  Mask:255.255.255.0
          inet6 addr: fe80::9879:d1ff:fe20:f4e7/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:2044  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:9 overruns:0 carrier:0
          collisions:0 txqueuelen:1024
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)
```

Step 4 Repeat Step 2 and Step 3 on the remaining interface(s).

Subinterfaces

This section describes subinterfaces. Subinterfaces divide primary (parent) interfaces to provide traffic isolation. Partition assignments distinguish subinterfaces from parent interfaces. The default Partition Key (p_key), ff:ff, applies to the primary (parent) interface.

This section includes the following topics:

Creating a Subinterface Associated with a Specific IB Partition

To create a subinterface associated with a specific IB partition, perform the following steps:

Step 1 Create a partition on an IB SFS. Alternatively, you can choose to create the partition of the IB interface on the host first, and then create the partition for the ports on the IB SFS. See the *Cisco SFS Product Family Element Manager User Guide* for information regarding valid partitions on the IB SFS.

Step 2 Log in to your host.

Step 3 Add the value of the partition key to the file as root user.

The following example shows how to add partition 80:02 to the primary interface ib0:

```
host1# /usr/local/topspin/sbin/ipoibcfg add ib0 80:02
```

Step 4 Verify that the interface is set up by ensuring that ib0.8002 is displayed.

The following example shows how to verify the interface:

```
host1# ls /sys/class/net
eth0 ib0  ib0.8002  ib1  lo  sit0
```

Step 5 Verify that the interface was created by entering the **ifconfig -a** command.

The following example shows how to enter the **ifconfig -a** command:

```
host1# ifconfig -a
eth0      Link encap:Ethernet  HWaddr 00:30:48:20:D5:D1
          inet addr:172.29.237.206  Bcast:172.29.239.255  Mask:255.255.252.0
          inet6 addr: fe80::230:48ff:fe20:d5d1/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:9091465 errors:0 dropped:0 overruns:0 frame:0
          TX packets:505050 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1517373743 (1.4 GiB)  TX bytes:39074067 (37.2 MiB)
          Base address:0x3040 Memory:dd420000-dd440000

ib0       Link encap:Ethernet  HWaddr F8:79:D1:23:9A:2B
          inet addr:192.168.0.1 Bcast:192.168.0.255  Mask:255.255.255.0
          inet6 addr: fe80::9879:d1ff:fe20:f4e7/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:2044  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:9 overruns:0 carrier:0
          collisions:0 txqueuelen:1024
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)

ib0.8002  Link encap:Ethernet  HWaddr 00:00:00:00:00:00
          BROADCAST MULTICAST  MTU:2044  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1024
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:378 errors:0 dropped:0 overruns:0 frame:0
          TX packets:378 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:45730 (44.6 KiB)  TX bytes:45730 (44.6 KiB)

sit0      Link encap:IPv6-in-IPv4
```

```
          NOARP  MTU:1480  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)
```

Verify that you see the ib0.8002 output.

Step 6 Configure the new interface just as you would the parent interface. (See the "Manually Configuring IPoIB for Default IB Partition" section on page 3-2.)

The following example shows how to configure the new interface:

```
host1# ifconfig ib0.8002 192.168.12.1 netmask 255.255.255.0
```

Removing a Subinterface Associated with a Specific IB Partition

To remove a subinterface, perform the following steps:

Step 1 Take the subinterface offline. You cannot remove a subinterface until you bring it down.

The following example shows how to take the subinterface offline:

```
host1# ifconfig ib0.8002 down
```

Step 2 Remove the value of the partition key to the file as root user.

The following example shows how to remove the partition 80:02 from the primary interface ib0:

```
host1# /usr/local/topspin/sbin/ipoibcfg del ib0 80:02
```

Step 3 (Optional) Verify that the subinterface no longer appears in the interface list by entering the **ifconfig -a** command.

The following example shows how to verify that the subinterface no longer appears in the interface list:

```
host1# ifconfig -a
eth0      Link encap:Ethernet  HWaddr 00:30:48:20:D5:D1
          inet addr:172.29.237.206  Bcast:172.29.239.255  Mask:255.255.252.0
          inet6 addr: fe80::230:48ff:fe20:d5d1/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:9091465 errors:0 dropped:0 overruns:0 frame:0
          TX packets:505050 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1517373743 (1.4 GiB)  TX bytes:39074067 (37.2 MiB)
          Base address:0x3040 Memory:dd420000-dd440000

ib0       Link encap:Ethernet  HWaddr F8:79:D1:23:9A:2B
          inet addr:192.168.0.1 Bcast:192.168.0.255  Mask:255.255.255.0
          inet6 addr: fe80::9879:d1ff:fe20:f4e7/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:2044  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:9 overruns:0 carrier:0
          collisions:0 txqueuelen:1024
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)

ib0.8002  Link encap:Ethernet  HWaddr 00:00:00:00:00:00
          BROADCAST MULTICAST  MTU:2044  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
```

```
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1024
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:378 errors:0 dropped:0 overruns:0 frame:0
          TX packets:378 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:45730 (44.6 KiB)  TX bytes:45730 (44.6 KiB)

sit0      Link encap:IPv6-in-IPv4
          NOARP  MTU:1480  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)
```

Verifying IPoIB Functionality

To verify your configuration and your IPoIB functionality, perform the following steps:

Step 1 Log in to your hosts.

Step 2 Verify the IPoIB functionality by using the **ifconfig** command.

The following example shows how two IB nodes are used to verify IPoIB functionality. In the following example, IB node 1 is at 192.168.0.1, and IB node 2 is at 192.168.0.2:

```
host1# ifconfig ib0 192.168.0.1 netmask 255.255.252.0
host2# ifconfig ib0 192.168.0.2 netmask 255.255.252.0
```

Step 3 Enter the **ping** command from 192.168.0.1 to 192.168.0.2.

The following example shows how to enter the **ping** command:

```
host1# ping -c 5 192.168.0.2
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=0 ttl=64 time=0.079 ms
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=0.044 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=64 time=0.055 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=64 time=0.049 ms
64 bytes from 192.168.0.2: icmp_seq=4 ttl=64 time=0.065 ms

--- 192.168.0.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 3999ms rtt min/avg/max/mdev =
0.044/0.058/0.079/0.014 ms, pipe 2
```

IPoIB Performance

This section describes how to verify IPoIB performance by running the Bandwidth test and the Latency test. These tests are described in detail at the following URL:

http://www.netperf.org/netperf/training/Netperf.html

To verify IPoIB performance, perform the following steps:

Step 1 Download Netperf from the following URL:

http://www.netperf.org/netperf/NetperfPage.html

Step 2 Compile Netperf by following the instructions at http://www.netperf.org/netperf/NetperfPage.html.

Step 3 Start the Netperf server.

The following example shows how to start the Netperf server:

```
host1$ netserver
Starting netserver at port 12865
Starting netserver at hostname 0.0.0.0 port 12865 and family AF_UNSPEC
host1$
```

Step 4 Run the Netperf client. The default test is the Bandwidth test.

The following example shows how to run the Netperf client, which starts the Bandwidth test by default:

```
host2$ netperf -H 192.168.0.1 -c -C -- -m 65536
TCP STREAM TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to 192.168.0.1 (192.168.0.1) port 0
AF_INET
Recv   Send    Send                          Utilization       Service Demand
Socket Socket  Message  Elapsed              Send     Recv     Send    Recv
Size   Size    Size     Time     Throughput  local    remote   local   remote
bytes  bytes   bytes    secs.    10^6bits/s  % S      % S      us/KB   us/KB

 87380  16384  65536    10.00      2701.06   46.93    48.73    5.694   5.912
```

Note You must specify the IPoIB IP address when running the Netperf client.

The following list describes parameters for the **netperf** command:

-H	Where to find the server
192.168.0.1	IPoIB IP address
-c	Client CPU utilization
-C	Server CPU utilization
--	Separates the global and test-specific parameters
-m	Message size, which is 65536 in the example above

The notable performance values in the example above are as follows:

Throughput is 2.70 gigabits per second.

Client CPU utilization is 46.93 percent of client CPU.

Server CPU utilization is 48.73 percent of server CPU.

Step 5 Run the Netperf Latency test.

Run the test once, and stop the server so that it does not repeat the test.

The following example shows how to run the Latency test, and then stop the Netperf server:

```
host2$ netperf -H 192.168.0.1 -c -C -t TCP_RR -- -r 1,1
TCP REQUEST/RESPONSE TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to 192.168.0.1
(192.168.0.1) port 0 AF_INET
Local /Remote
Socket Size   Request Resp.  Elapsed Trans.   CPU    CPU    S.dem   S.dem
Send   Recv   Size    Size   Time    Rate     local  remote local   remote
bytes  bytes  bytes   bytes  secs.   per sec  % S    % S    us/Tr   us/Tr

16384  87380  1       1      10.00   17228.96  12.98  12.30  30.146  28.552
16384  87380
```

The following list describes parameters for the **netperf** command:

-H	Where to find the server
192.168.0.1	IPoIB IP address
-c	Client CPU utilization
-C	Server CPU utilization
-t	Test type
TCP_RR	TCP required response test
--	Separates the global and test-specific parameters
-r 1,1	The request size sent and how many bytes requested back

The notable performance values in the example above are as follows:

Client CPU utilization is 12.98 percent of client CPU.

Server CPU utilization is 12.30 percent of server CPU.

Latency is 29.02 microseconds. Latency is calculated as follows:

(1 / Transaction rate per second) / 2 * 1,000,000 = one-way average latency in microseconds

Step 6 To end the test, shut down the Netperf server.

```
host1$ pkill netserver
```

Sample Startup Configuration File

IP addresses that are configured manually are not persistent across reboots. You must use a configuration file to configure IPoIB when the host boots. Two sample configurations are included in this section.

The following sample configuration shows an example file named ifcfg-ib0 that resides on a Linux host in /etc/sysconfig/networks-scripts/ on RHEL3 and RHEL4. The configuration file configures an IP address at boot time.

```
host1# cat > /etc/sysconfig/network-scripts/ifcfg-ib0 << EOF
> DEVICE=ib0
> BOOTPROTO=static
> IPADDR=192.168.0.1
> NETMASK=255.255.255.0
> ONBOOT=yes
> EOF
```

The following sample configuration shows an example file named ifcfg-ib0 in /etc/sysconfig/network/ on SLES10. The configuration file configures an IP address at boot time.

```
host1# cat > /etc/sysconfig/network/ifcfg-ib0 << EOF
> DEVICE=ib0
> BOOTPROTO=static
> IPADDR=192.168.0.1
> NETMASK=255.255.255.0
> STARTMODE=auto
> EOF
```

IPoIB High Availability

This section describes IPoIB high availability. IPoIB supports active/passive port failover high availability between two or more ports. When you enable the high availability feature, the ports on the HCA (for example, ib0 and ib1) merge into one virtual port. If you configure high availability between the ports on the HCA(s), only one of the physical ports passes traffic. The other ports are used as standby in the event of a failure. This section includes the following topics:

Merging Physical Ports

To configure IPoIB high availability on HCA ports in a Linux host, perform the following steps:

Step 1 Log in to your Linux host.

Step 2 Display the available interfaces by entering the **ipoibcfg list** command. The following example shows how to configure IPoIB high availability between two ports on one HCA.

The following example shows how to display the available interfaces:

```
host1# /usr/local/topspin/sbin/ipoibcfg list
ib0 (P_Key 0xffff) (SL:255) (Ports: InfiniHost0/1, Active: InfiniHost0/1)
ib1 (P_Key 0xffff) (SL:255) (Ports: InfiniHost0/2, Active: InfiniHost0/2)
```

Step 3 Take the interfaces offline. You cannot merge interfaces until you bring them down.

The following example shows how to take the interfaces offline:

```
host1# ifconfig ib0 down
host1# ifconfig ib1 down
```

Step 4 Merge the two ports into one virtual IPoIB high availability port by entering the **ipoibcfg merge** command with the IB identifiers of the first and the second IB ports on the HCA.

The following example shows how to merge the two ports into one virtual IPoIB high availability port:

```
host1# /usr/local/topspin/sbin/ipoibcfg merge ib0 ib1
```

Step 5 Display the available interfaces by entering the **ipoibcfg list** command.

The following example shows how to display the available interfaces:

```
host1# /usr/local/topspin/sbin/ipoibcfg list
ib0 (P_Key 0xffff) (SL:255) (Ports: InfiniHost0/1, Active: InfiniHost0/1)
```

Note The ib1 interface no longer appears, as it is merged with ib0.

Step 6 Enable the interface by entering the **ifconfig** command with the appropriate port identifier *ib*# argument and the **up** keyword.

The following example shows how to enable the interface with the **ifconfig** command:

```
host1# ifconfig ib0 up
```

Step 7 Assign an IP address to the merged port just as you would assign an IP address to a standard interface.

Unmerging Physical Ports

To unmerge physical ports and disable active-passive IPoIB high availability, perform the following steps:

Step 1 Disable the IPoIB high availability interface that you want to unmerge by entering the **ifconfig** command with the appropriate IB interface argument and the **down** argument.

The following example shows how to unmerge by disabling the IPoIB high availability interface:

```
host1# ifconfig ib0 down
```

Step 2 Unmerge the port by entering the **ipoibcfg unmerge** command with the identifier of the port that you want to unmerge.

The following example shows how to unmerge the port:

```
host1# /usr/local/topspin/sbin/ipoibcfg unmerge ib0 ib1
```

Note After the unmerge, ib1 no longer has an IP address and needs to be configured.

Step 3 Display the available interfaces by entering the **ipoibcfg list** command.

The following example shows how to display the available interfaces:

```
host1# /usr/local/topspin/sbin/ipoibcfg list
ib0 (P_Key 0xffff) (SL:255) (Ports: InfiniHost0/1, Active: InfiniHost0/1)
ib1 (P_Key 0xffff) (SL:255) (Ports: InfiniHost0/2, Active: InfiniHost0/2)
```

Step 4 Enable the interfaces by entering the **ifconfig** command with the appropriate IB interface argument and the **up** argument.

The following example shows how to enable the interfaces:

```
host1# ifconfig ib0 up
```

CHAPTER 4

SCSI RDMA Protocol

This chapter describes SCSI RDMA protocol and includes the following sections:

Note See the "Root and Non-root Conventions in Examples" section on page ix for details about the significance of prompts used in the examples in this chapter.

Introduction

SRP runs SCSI commands across RDMA-capable networks so that IB hosts can communicate with Fibre Channel storage devices and IB-attached storage devices. SRP requires an SFS with a Fibre Channel gateway to connect the host to Fibre Channel storage. In conjunction with an SFS, SRP masks IB-attached hosts as Fibre Channel-attached hosts. The topology transparency feature enables Fibre Channel storage to communicate seamlessly with IB-attached hosts, called SRP hosts.

To connect an IB-attached SRP host to a SAN, cable your SRP host to an IB fabric that includes an SFS with a Fibre Channel gateway or IB-attached storage. Log in to the SFS to configure the Fibre Channel connection between the SAN and the SRP host, and then log in to the host and configure the SRP host.

Configuring SRP

This section describes how to configure SRP. There are a number of ways to configure the connection between the SAN and the SRP host. The method that you choose depends on the interfaces available to you and the global access settings on your SFS. The instructions in this section provide one example of how to configure the connection. For detailed instructions, see the *Cisco SFS InfiniBand Fibre Channel Gateway User Guide.*

Note If you have a Fibre Channel gateway, you must configure ITLs. If you have IB-attached storage, see the relevant storage documentation.

This section contains information on how to configure your IB fabric to connect an SRP host to a SAN and includes the following topics:

Note If you intend to manage your environment with Cisco VFrame software, do not configure ITLs.

Configuring ITLs when Using Fibre Channel Gateway

This section describes how to configure ITLs when using Fibre Channel gateway. When you configure initiators, you assign Fibre Channel WWNNs to SRP hosts so that the SAN can recognize the hosts. Steps to configure initiators are provided in this section.

To configure initiators that you have not yet connected to your fabric, enter the GUID of the initiator into the CLI or Element Manager so that the configuration works when you connect the SRP host.

You must configure ITLs for your initiators to communicate with your storage. You can configure ITLs with the CLI or the Element Manager GUI.

- If you restricted port and LUN access when you configured global attributes, proceed to the "Configuring ITLs with Element Manager while Global Policy Restrictions Apply" section on page 4-4.
- If you have not configured access, perform the steps as appropriate in "Configuring ITLs with Element Manager while No Global Policy Restrictions Apply" section on page 4-2 or in "Configuring ITLs with Element Manager while Global Policy Restrictions Apply" section on page 4-4.

Note If you enter a Fibre Channel command and receive an error message that reads `Operation temporarily failed - try again`, give your Fibre Channel gateway time to finish initializing, and then retry the command.

Configuring ITLs with Element Manager while No Global Policy Restrictions Apply

This section describes how to configure ITLs with Element Manager while no global policy restrictions apply. To configure ITLs with a Linux SRP host while your port masking and LUN masking policies are unrestricted, perform the following steps:

Step 1 Log in to your host.

Step 2 Display the host GUID by entering the **hca_self_test | grep -i guid** command.

Note Record the GUID value (always similar format 00:00:00:00:00:00:00:00). You are required later to enter it repeatedly.

Step 3 Bring up the Fibre Channel gateways on your SFS, by performing the following steps:

a. Launch Element Manager.

b. Double-click the Fibre Channel gateway card that you want to bring up. The Fibre Channel Card window opens.

c. Click the **Up** radio button in the Enable/Disable Card field, and then click **Apply**.

d. (Optional) Repeat this process for additional gateways.

The Fibre Channel gateway automatically discovers all attached storage.

Note Discovered LUs remain gray (inactive) until an SRP host connects to them. Once a host connects to an LU, its icon becomes blue (active). Hosts do not stay continually connected to LUs, so the color of the icon may change.

Step 4 From the Fibre Channel menu of the Element Manager, choose **Storage Manager**. The Cisco Storage Manager window opens.

Step 5 Click the **SRP Hosts** folder in the Storage navigation tree in the left-hand frame of the interface. The SRP Hosts display appears in the right-hand frame of the interface.

Step 6 Click **Define New** in the SRP Hosts display. The Define New SRP Host window opens.

Note If your host includes multiple HCAs, you must configure each individual HCA as an initiator. When you configure one HCA in a host, other HCAs in the host are not automatically configured.

Step 7 Choose a GUID from the Host GUID drop-down menu in the Define New SRP Host window. The menu displays the GUIDs of all connected hosts that you have not yet configured as initiators.

Step 8 (Optional) Type a description in the Description field in the Define New SRP Host window.

Step 9 Click the **Next >** button. The Define New SRP Host window displays a recommended WWNN for the host and recommended WWPNs that represent the host on all existing and potential Fibre Channel gateway ports.

Note Although you can manually configure the WWNN or WWPNs, use the default values to avoid conflicts.

Step 10 Click the **Finish** button. The new host appears in the SRP Hosts display.

Step 11 Expand the **SRP Hosts** folder in the Storage navigation tree, and then click the host that you created. The host display appears in the right-hand frame of the interface.

Step 12 (Optional) Click the **LUN Access** tab in the host display, and then click **Discover LUNs**. The targets and associated LUNs that your Fibre Channel gateway sees appear in the Accessible LUNs field.

Step 13 Click **Refresh** in the Cisco Storage Manager window.

Configuring ITLs with Element Manager while Global Policy Restrictions Apply

This section describes how to configure ITLs with Element Manager while global policy restrictions apply. These instructions apply to environments where the portmask policy and LUN masking policy are both restricted. To verify that you have restricted your policies, enter the **show fc srp-global** command at the CLI prompt. View the default-gateway-portmask-policy and default-lun-policy fields. If restrictions apply to either field, **restricted** appears in the field output.

To configure ITLs with a Linux SRP host while your port masking and LUN masking policies are restricted, perform the following steps:

Step 1 Log in to your host.

Step 2 Display the host GUID by entering the **hca_self_test | grep -i guid** command at the host CLI.

Note Record the GUID value. You are required later to enter it repeatedly.

Step 3 Bring up the Fibre Channel gateways on your server switch with the following steps:

a. Launch Element Manager.

b. Double-click the Fibre Channel gateway card that you want to bring up. The Fibre Channel Card window opens.

c. Click the **Up** radio button in the **Enable/Disable Card** field, and then click **Apply**.

d. (Optional) Repeat this process for additional gateways.

The Fibre Channel gateway automatically discovers all attached storage.

Note Discovered LUs remain gray (inactive) until an SRP host connects to them. Once a host connects to an LU, its icon becomes blue (active).

Step 4 From the Fibre Channel menu, select **Storage Manager.**

Step 5 Click the **SRP Hosts** folder in the Storage navigation tree in the left-hand frame of the interface. The SRP Hosts display appears in the right-hand frame of the interface.

Step 6 Click **Define New** in the SRP Hosts display. The Define New SRP Host window opens.

Note If your host includes multiple HCAs, you must configure each individual HCA as an initiator. When you configure one HCA in a host, other HCAs in the host are not automatically configured.

Step 7 Select a GUID from the Host GUID drop-down menu in the Define New SRP Host window. The menu displays the GUIDs of all available hosts that you have not yet configured as initiators.

Step 8 (Optional) Type a description in the Description field in the Define New SRP Host window. If you do not enter a description, your device will assign a description.

Step 9 Click the **Next >** button. The Define New SRP Host window displays a recommended WWNN for the host and recommended WWPNs that represent the host on all existing and potential Fibre Channel gateway ports.

Note Although you can manually configure the WWNN or WWPNs, we recommend that you use the default values to avoid conflicts.

Step 10 Click **Finish**. The new host appears in the SRP Hosts display.

Step 11 Expand the **SRP Hosts** folder in the Storage navigation tree, and then click the host that you created. The host display appears in the right-hand frame of the interface.

Step 12 Click the **Targets** tab in the host display. Double-click the WWPN of the target that you want your host to access. The IT Properties window opens.

Step 13 Click the **...** button next to the Port Mask field. The Select Port(s) window opens and displays two port numbers for each slot in the chassis. The *raised* port numbers represent restricted ports. The *pressed* port numbers represent accessible ports.

Step 14 Click the port(s) to which the SAN connects to grant the initiator access to the target through those ports, and then click **OK**.

Step 15 Click the **Apply** button in the IT Properties window, and then close the window.

Step 16 Click the **LUN Access** tab in the host display, and then click **Discover LUNs**. The targets and associated LUNs that your Fibre Channel gateway sees appear in the Available LUNs field.

Step 17 Click the **LUN Access** tab, click the target that you configured in Step 16, and then click **Add >**. The target and its LUN(s) appear in the Accessible LUNs field in an Inactive ITLs folder.

Step 18 Click the LUN that you want your host to reach, and then click **Edit ITL Properties**. The ITL Properties window opens.

Step 19 Click the **...** button next to the Port Mask field. The Select Port(s) window opens and displays two port numbers for each slot in the chassis. The *raised* port numbers represent restricted ports. The *pressed* port numbers represent accessible ports.

Step 20 Click the port(s) to which the SAN connects to grant the initiator access to the target through those ports, and then click the **OK** button.

Step 21 Click the **Refresh** button in the Cisco Storage Manager window.

Configuring SRP Host

This section describes how to configure the SRP host. The SRP host driver exposes a Fibre Channel target (identified by a WWPN) as a SCSI target to the Linux SCSI mid-layer. In turn, the mid-layer creates Linux SCSI devices for each LUN found behind the target. The SRP host driver provides failover and load balancing for multiple IB paths for a given target. LUNs accessible from multiple targets can be managed through third-party multipathing software running a layer above the SRP host driver.

The SRP driver is automatically loaded at boot time by default. To disable loading the SRP driver at boot time, run **chkconfig ts_srp off**. The SRP driver can be loaded manually with **modprobe ts_srp_host** and unloaded with **rmmod ts_srp_host.**

To configure the SRP host, perform the following steps:

Step 1 Check for SCSI disks before configuring SRP.

The following example shows how to check for SCSI disk:

```
host1# cat /proc/scsi/scsi
Attached devices:
Host: scsi0 Channel: 00 Id: 01 Lun: 00
  Vendor: SEAGATE  Model: ST373307LC       Rev: 0006
  Type:   Direct-Access                    ANSI SCSI revision: 03
Host: scsi0 Channel: 00 Id: 06 Lun: 00
  Vendor: SDR      Model: GEM318P          Rev: 1
  Type:   Processor                        ANSI SCSI revision: 02
```

The above example shows one local Seagate Model ST373307LC SCSI disk.

Step 2 Reload the SRP host driver after configuring access.

The following example reloads the SRP host driver after configuring access:

```
host1# modprobe ts_srp_host
```

Step 3 Check for SCSI disks after configuring SRP.

The following example checks for SCSI disks after configuring SRP:

```
host1# cat /proc/scsi/scsi
Attached devices:
Host: scsi0 Channel: 00 Id: 01 Lun: 00
  Vendor: SEAGATE  Model: ST373307LC       Rev: 0006
  Type:   Direct-Access                    ANSI SCSI revision: 03
Host: scsi0 Channel: 00 Id: 06 Lun: 00
  Vendor: SDR      Model: GEM318P          Rev: 1
  Type:   Processor                        ANSI SCSI revision: 02
Host: scsi1 Channel: 00 Id: 00 Lun: 31
  Vendor: SUN      Model: T4               Rev: 0300
  Type:   Direct-Access                    ANSI SCSI revision: 03
Host: scsi1 Channel: 00 Id: 00 Lun: 32
  Vendor: SUN      Model: T4               Rev: 0300
  Type:   Direct-Access                    ANSI SCSI revision: 03
```

Two additional Sun Model T4 SRP LUNs are available after the configuration is complete.

Verifying SRP

This section describes how to verify SRP functionality and verify SRP host-to-storage connections with the Element Manager GUI and includes the following sections:

Verifying SRP Functionality

To verify SRP functionality, perform the following steps:

Step 1 Log in to your SRP host.

Step 2 Create a disk partition.

The following example shows how to partition a disk by using approximately half of the first SRP disk:

```
host1# fdisk /dev/sdb
Device contains neither a valid DOS partition table, nor Sun, SGI or OSF disklabel
Building a new DOS disklabel. Changes will remain in memory only,
until you decide to write them. After that, of course, the previous
content won't be recoverable.

The number of cylinders for this disk is set to 8200.
There is nothing wrong with that, but this is larger than 1024,
and could in certain setups cause problems with:
1) software that runs at boot time (e.g., old versions of LILO)
2) booting and partitioning software from other OSs
(e.g., DOS FDISK, OS/2 FDISK)
Warning: invalid flag 0x0000 of partition table 4 will be corrected by w(rite)
Command (m for help): p
Disk /dev/sdb: 8598 MB, 8598847488 bytes
64 heads, 32 sectors/track, 8200 cylinders
Units = cylinders of 2048 * 512 = 1048576 bytes
Device Boot Start End Blocks Id System
Command (m for help): n
Command action
e extended
p primary partition (1-4)
p
Partition number (1-4): 1
First cylinder (1-8200, default 1):
Using default value 1
Last cylinder or +size or +sizeM or +sizeK (1-8200, default 8200): 4000
Command (m for help): w
The partition table has been altered!
Calling ioctl() to re-read partition table.
Syncing disks.
```

Step 3 Create a file system on the partition.

The following example shows how to create a file system on the partition:

```
host1 # mke2fs -j /dev/sdb1
mke2fs 1.35 (28-Feb-2004)
Filesystem label=
OS type: Linux
Block size=4096 (log=2)
Fragment size=4096 (log=2)
```

```
512000 inodes, 1023996 blocks
51199 blocks (5.00%) reserved for the super user
First data block=0
Maximum filesystem blocks=1048576000
32 block groups
32768 blocks per group, 32768 fragments per group
16000 inodes per group
Superblock backups stored on blocks:
32768, 98304, 163840, 229376, 294912, 819200, 884736
Writing inode tables: done
Creating journal (8192 blocks): done
Writing superblocks and filesystem accounting information: done
This filesystem will be automatically checked every 38 mounts or
180 days, whichever comes first. Use tune2fs -c or -i to override.
host1# mount /dev/sdb1 /mnt
host1# df -k
Filesystem           1K-blocks      Used Available Use% Mounted on
/dev/sda3             68437272   7811640  57149168  13% /
/dev/sda1               101086     13159     82708  14% /boot
none                   3695248         0   3695248   0% /dev/shm
sjc-filer25a.cisco.com:/data/home
                     1310720000 1217139840  93580160  93% /data/home
sjc-filer25a.cisco.com:/software
                     943718400 839030128 104688272  89% /data/software
sjc-filer25b.cisco.com:/qadata
                     1353442040 996454024 356988016  74% /qadata
/dev/sdb1              4031664     40800   3786068   2% /mnt
```

Step 4 Write some data to the file system.

The following example shows how to write some data to the file system:

```
host1# dd if=/dev/zero of=/mnt/dd.test count=1000
1000+0 records in
1000+0 records out
host1# ls -l /mnt/dd.test
-rw-r--r-- 1 root root 512000 Jul 25 13:25 /mnt/dd.test
```

Verifying with Element Manager

To verify that your host connects successfully to Fibre Channel storage, perform the following steps:

Step 1 Launch Element Manager and log in to the SFS that connects your SRP host to Fibre Channel storage.

Step 2 From the FibreChannel menu, choose **Storage Manager**. The Storage Manager window opens.

Step 3 Expand the SRP hosts folder in the Storage navigation tree. A list of SRP hosts appears. Those SRP hosts that are successfully connected to storage appear as blue icons.

Step 4 (Optional) Verify LUN access with the following steps:

- **a.** Click an SRP host in the Storage navigation tree.
- **b.** Click the **LUN Access** tab in the right-hand frame of the display.
- **c.** Expand all icons in the Accessible LUNs field. Those SRP hosts that are successfully connected to LUNs appear as blue LUN icons.

CHAPTER 5

Sockets Direct Protocol

This chapter describes the Sockets Direct Protocol and includes the following sections:

Note See the "Root and Non-root Conventions in Examples" section on page ix for details about the significance of prompts used in the examples in this chapter.

Introduction

SDP is an IB-specific upper layer protocol. It defines a standard wire protocol to support stream sockets networking over IB. SDP enables sockets-based applications to take advantage of the enhanced performance features provided by IB and achieves lower latency and higher bandwidth than IPoIB running sockets-based applications. It provides a high-performance, zero-copy data transfer protocol for stream-socket networking over an IB fabric. You can configure the driver to automatically translate TCP to SDP based on source IP, destination, or application name.

Configuring IPoIB Interfaces

SDP uses the same IP addresses and interface names as IPoIB. Configure the IPoIB IP interfaces if you have not already done so. (See Chapter 3, "IP over IB Protocol.")

Converting Sockets-Based Application

This section describes how to convert sockets-based applications. You can convert your sockets-based applications to use SDP instead of TCP by using one of two conversion types. This section includes the following topics:

Explicit/Source Code Conversion Type

The explicit or source code conversion type method converts sockets to use SDP based on application source code. This method is useful when you want full control from your application when using SDP.

To use this method, change your source code to use AF_INET_SDP instead of AF_INET when calling the socket() system call.

AF_INET _SDP is defined as 26. Add the following line of code to the beginning of your program:

```
#define AF_INET_SDP 26
```

Automatic Conversion Type

This section describes automatic conversion type. Use a text editor to open the libsdp configuration file (located in /usr/local/topspin/etc/libsdp.conf). This file defines when to automatically use SDP instead of TCP. You may edit this file to specify connection overrides. Use the environment variable LIBSDP_CONFIG_FILE to specify an alternate configuration file.

The automatic conversion type method converts socket streams based upon a destination port, listening port, or program name.

Load the installed libsdp.so library using either of these two methods:

- Set the LD_PRELOAD environment variable to libsdp.so before running the executable.
- Add the full path of the library into /etc/ld.so.preload. This action causes the library to preload for every executable that is linked with libc.

This configuration file supports two main types of statements:

- **log**

  The **log** keyword sets logging-related configurations. The log settings take immediate effect, so they are defined at the beginning of the file.

- **match**

  The **match** keyword enables the user to specify when libsdp replaces AF_INET/SOCK_STREAM sockets with AF_INET_SDP/SOCK_STREAM sockets.

Log Statement

This section describes the log statement. The log directive allows the user to specify which debug and error messages are sent and where they are sent. The log statement format is as follows:

log [destination stderr | syslog | file *filename*] [min-level *1-9*]

Command	Description
destination	Defines the destination of the log messages.
stderr	Forwards messages to the STDERR.
syslog	Sends messages to the syslog service.
file *filename*	Writes messages to the file/tmp/filename.
min-level	Defines the verbosity of the log as follows: 9—Errors are printed. 3—Protocol-matching messages. 2—Socket-creation messages. 1—Function calls and return values.

The file destination must be relative to /tmp. This is to prevent non-superuser accounts from having the ability to create arbitrary files on the system. Any path components of the filename are stripped.

The following example shows how to get the full verbosity printed into the /tmp/libsdp.log file:

```
log min-level 1 destination file libsdp.log
```

The following example shows how to get the full verbosity printed into the /STDERR:

```
log min-level 1 destination stderr
```

Match Statement

This section describes the match statement. The match directive enables the user to specify when libsdp replaces AF_INET/SOCK_STREAM sockets with AF_SDP/SOCK_STREAM sockets. Each match directive specifies a group for which all expressions must evaluate as true (logical and).

The four expressions are as follows:

destination *ip_port*

listen *ip_port*

shared *ip_port*

program *program_name*

The syntax description for the match statement is as follows:

destination	This expression enables the user to match a client-connect request and convert the TCP socket to an SDP socket. The rule is applied during the connect system call.
listen	This expression enables the user to match a server-bind request and convert the TCP socket to an SDP socket. The rule is applied during the bind system call.

shared	This expression enables the user to match a server-bind request and then listen and accept incoming connections on both TCP and SDP protocols.
program	This expression enables the user to match the program name.

The ip_port matches against an IP address, prefix length, and port range. The format is as follows:

ip_addr[/*prefix_length*][:*start_port*[-*end_port*]]

The prefix length is optional and missing defaults to /32 (length of one host). The ending port in the range is optional and is missing defaults to the port specified by the starting point. The *ip_addr* variable or *start_port* variable can be *, which means any IP or any port, respectively.

The *program_name* variable matches on shell style globs. The db2* value matches on any program with a name starting with db2, and the t?cp matches on ttcp. These are examples of program names:

```
match listen *:5001 program ttcp
match shared *:5002
match destination 192.168.1.0/24
match program db2*
```

SDP Performance

This section describes how to verify SDP performance by running the Netperf Bandwidth test and the Latency test. These tests are described in detail at the following URL:

http://www.netperf.org/netperf/training/Netperf.html

To verify SDP performance, perform the following steps:

Step 1 Download Netperf from the following URL:

http://www.netperf.org/netperf/NetperfPage.html

Step 2 Follow the instructions at http://www.netperf.org/netperf/NetperfPage.html to compile Netperf.

Step 3 Create a libsdp configuration file.

```
host1$ cat > $HOME/libsdp.conf << EOF
> match destination *:*
> match listen *:*
> EOF
```

Step 4 Run the Netperf server, which forces SDP to be used instead of TCP.

The following example shows how to run the Netperf server with SDP:

```
host1$ LD_PRELOAD=libsdp.so LIBSDP_CONFIG_FILE=$HOME/libsdp.conf netserver
Starting netserver at port 12865
Starting netserver at hostname 0.0.0.0 port 12865 and family AF_UNSPEC
host1$
```

Step 5 Run the Netperf Bandwidth test, which forces SDP to be used instead of TCP.

The following example shows how to run the Netperf Bandwidth test with SDP:

```
host2$ LD_PRELOAD=libsdp.so LIBSDP_CONFIG_FILE=$HOME/libsdp.conf netperf -H 192.168.0.1 -c
-C -- -m 65536
TCP STREAM TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to 192.168.0.1 (192.168.0.1)
port 0 AF_INET
Recv   Send    Send                          Utilization       Service Demand
```

```
Socket Socket  Message  Elapsed              Send     Recv     Send    Recv
Size   Size    Size     Time     Throughput  local    remote   local   remote
bytes  bytes   bytes    secs.    10^6bits/s  % S      % S      us/KB   us/KB

 87380  16384  65536    10.00      6601.82   23.79    21.37    1.181   1.061
```

The following list describes the parameters for the **netperf** command:

-H	Where to find the server
192.168.0.1	IPoIB IP address
-c	Client CPU utilization
-C	Server CPU utilization
--	Separates the global and test-specific parameters
-m	The message size, which is 65536 in the example above

The notable performance values in the example above are as follows:

Throughput is 6.60 gigabits per second.

Client CPU utilization is 23.79 percent of the client CPU.

Server CPU utilization is 21.37 percent of the server CPU.

Step 6 Run the Netperf Latency test, which forces SDP to be used instead of TCP.

After the test runs once, stop the server so that it does not repeat the test.

The following example shows how to run the Netperf Latency test with SDP:

```
host2$ LD_PRELOAD=libsdp.so LIBSDP_CONFIG_FILE=$HOME/libsdp.conf netperf -H 192.168.0.1 -c
-C -t TCP_RR -- -r 1,1
TCP REQUEST/RESPONSE TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to 192.168.0.1
 (192.168.0.1) port 0 AF_INET
Local /Remote
Socket Size   Request Resp.  Elapsed Trans.   CPU    CPU    S.dem   S.dem
Send   Recv   Size    Size   Time    Rate     local  remote local   remote
bytes  bytes  bytes   bytes  secs.   per sec  % S    % S    us/Tr   us/Tr

16384  87380  1       1      10.00   27754.33  6.26   7.22   9.029   10.408
16384  87380
Stop netperf server.
```

The following list describes parameters for the **netperf** command:

-H	Where to find the server
192.168.0.1	IPoIB IP address
-c	Client CPU utilization
-C	Server CPU utilization
-t	Test type
TCP_RR	TCP request response test
--	Separates the global and test-specific parameters
-r 1,1	Request size sent and how many bytes requested back

The notable performance values in the example above are as follows:

Client CPU utilization is 6.26 percent of client CPU.

Server CPU utilization is 7.22 percent of server CPU.

Latency is 18.01 microseconds. Latency is calculated as follows:

(1 / Transaction rate per second) / 2 * 1,000,000 = one-way average latency in microseconds

Step 7 To end test, shutdown the Netperf server.

The following example shows how to shutdown the Netperf server:

```
host1$ pkill netserver
```

Netperf Server with IPoIB and SDP

This section describes how to use the Netperf server with IPoIB and SDP. When using libsdp, it is possible for the Netperf server to work with both IPoIB and SDP. To use Netperf server with IPoIB and SDP, perform the following steps:

Step 1 Create the libsdp configuration file.

The following example shows how to create the libsdp configuration file:

```
host1$ echo "match shared *:*" > $HOME/both.conf
```

Step 2 Ensure that the Netperf server is not running already, and then start the Netperf server.

The following example stops the Netperf server if it is already running and then starts the server:

```
host1$ pkill netserver
host1$ LD_PRELOAD=libsdp.so LIBSDP_CONFIG_FILE=$HOME/both.conf netserver
Starting netserver at port 12865
Starting netserver at hostname 0.0.0.0 port 12865 and family AF_UNSPEC
```

Step 3 Run the Netperf Bandwidth test, which forces SDP to be used instead of TCP.

The following example shows how to run the Netperf Bandwidth test with SDP:

```
host2$ LD_PRELOAD=libsdp.so LIBSDP_CONFIG_FILE=$HOME/libsdp.conf netperf -H 192.168.0.1 -c
-C -- -m 65536
TCP STREAM TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to 192.168.0.1 (192.168.
0.206) port 0 AF_INET
Recv   Send    Send                          Utilization       Service Demand
Socket Socket  Message  Elapsed              Send     Recv     Send    Recv
Size   Size    Size     Time     Throughput  local    remote   local   remote
bytes  bytes   bytes    secs.    10^6bits/s  % S      % S      us/KB   us/KB

 87380  16384  65536    10.00      6601.82   23.79    21.37    1.181   1.061
```

The following list describes parameters for the **netperf** command:

-H	Where to find the server
192.168.0.1	IPoIB IP address
-c	Client CPU utilization
-C	Server CPU utilization
--	Separates the global and test-specific parameters
-m	The message size, which is 65536 in the example above

The notable performance values in the example above are as follows:

Throughput is 6.60 gigabits per second.

Client CPU utilization is 23.79 percent of the client CPU.

Server CPU utilization is 21.37 percent of the server CPU.

Step 4 Run the Netperf client.

The default test is the Bandwidth test.

The following example shows how to run the Netperf client, which starts the Bandwidth test by default:

```
host2$ netperf -H 192.168.0.1 -c -C -- -m 65536
TCP STREAM TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to 192.168.0.1 (192.168.0.1) port 0
AF_INET
Recv   Send    Send                          Utilization       Service Demand
Socket Socket  Message  Elapsed              Send     Recv     Send    Recv
Size   Size    Size     Time     Throughput  local    remote   local   remote
bytes  bytes   bytes    secs.    10^6bits/s  % S      % S      us/KB   us/KB

 87380  16384  65536    10.00      2701.06   46.93    48.73    5.694   5.912
```

Note You must specify the IPoIB IP address when running the Netperf client.

The following list describes parameters for the **netperf** command:

-H	Where to find the server
192.168.0.1	IPoIB IP address
-c	Client CPU utilization
-C	Server CPU utilization
--	Separates the global and test-specific parameters
-m	Message size, which is 65536 in the example above

The notable performance values in the example above are as follows:

Throughput is 2.70 gigabits per second.

Client CPU utilization is 46.93 percent of client CPU.

Server CPU utilization is 48.73 percent of server CPU.

CHAPTER 6

uDAPL

This chapter describes uDAPL and includes the following sections:

Note See the "Root and Non-root Conventions in Examples" section on page ix for details about the significance of prompts used in the examples in this chapter.

Introduction

uDAPL defines a single set of user-level APIs for all RDMA-capable transports. uDAPL also defines a transport-independent and platform-standard set of APIs that takes advantage of RDMA capabilities such as those present in IB. To obtain uDAPL, install the drivers. No additional configuration is required to use uDAPL.

For additional details about uDAPL, go to the following URL:

http://www.datcollaborative.org

uDAPL Test Performance

This section describes the uDAPL test performance. The utility to test uDAPL performance is included with the RPMs after the host drivers are installed.

The uDAPL test utility is located in the following directory:

/usr/local/topspin/bin/

The uDAPL test must be run on a server and a client host.

uDAPL Throughput Test Performance

The Throughput test measures RDMA WRITE throughput using uDAPL. To perform a uDAPL Throughput test performance, perform the following steps:

Step 1 Start the Throughput test on the server host. The syntax for the server is as follows:

/usr/local/topspin/bin/thru_server.x *device_name RDMA_size iterations batch_size*

The following example shows how to start the Throughput test on the server host:

```
host1$ /usr/local/topspin/bin/thru_server.x ib0 262144 500 100
RDMA throughput server started on ib0
```

- **ib0** is the name of the device.
- **262144** is the size in bytes of the RDMA WRITE.
- **500** is the number of RDMAs to perform for the test.
- **100** is the number of RDMAs to perform before waiting for completions.

The server starts and then waits for the client to start.

Step 2 Start the Throughput test on the client. The syntax for the client is as follows:

/usr/local/topspin/bin/thru_client.x *device_name server_IP_address RDMA_size*

The following example shows how to start the Throughput test on the client:

```
host2$ /usr/local/topspin/bin/thru_client.x ib0 192.168.0.1 262144
Server Name: 192.168.0.1
Server Net Address: 192.168.0.1
dat_rmr_bind completed!
sending rmr_context = 1b3b78 target_address = 95e3a000 segment_length = 40000
```

- **ib0** is the name of the device.
- **192.168.0.1** is the IPoIB address of the server host.
- **262144** is the size in bytes of the RDMA WRITE.

Step 3 View the Throughput test results from the server.

The following example shows the Throughput test results:

```
Created an EP with ep_handle = 0x2a95f8a300
queried max_recv_dtos = 256
queried max_request_dtos = 1024
Accept issued...
Received an event on ep_handle = 0x2a95f8a300
Context = 29a
Connected!
received rmr_context = 1b3b78 target_address = 95e3a000 segment_length = 40000
Sent  7759.462 Mb in  1.0 seconds throughput =  7741.811 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.583 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.499 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.753 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.885 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.800 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.769 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.769 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.707 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7741.703 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.260 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.283 Mb/sec
Sent  7759.462 Mb in  1.0 seconds throughput =  7742.483 Mb/sec
total secs 13 throughput 7742 Mb/sec
Received an event on ep_handle = 0x2a95f8a300
Context = 29a
```

The notable performance result in the example is Throughput as 7.7 gigabits per second.

uDAPL Latency Test Performance

The uDAPL Latency test measures half of the round-trip latency for uDAPL sends. To perform a uDAPL Latency test performance, perform the following steps:

Step 1 Start the Latency test on the server host. The syntax for the server is as follows:

/usr/local/topspin/bin/lat_server.x *device_name iterations msg_size 0:poll/1:event*

The following example shows how to start the Latency test on the server host:

```
host1$ /usr/local/topspin/bin/lat_server.x ib0 200000 1 0
latency server started on ib0
```

- **ib0** is the name of the device.
- **200000** is the number of RDMAs to perform for the test.
- **1** is the size in bytes of the RDMA WRITE.
- **0** is a flag specifying whether polling or event should be used. 0 signifies polling, and 1 signifies events.

Step 2 Start the Latency test on the client.

The syntax for the client is as follows:

/usr/local/topspin/bin/lat_client.x *device_name server_name iterations msg_size 0:poll/1:event*

The following example shows how to start the Latency test on the client:

```
host2$ /usr/local/topspin/bin/lat_client.x ib0 192.168.0.1 200000 1 0
```

- **ib0** is the name of the device.
- **192.168.0.1** is the IPoIB address of the server host.
- **200000** is the number of RDMAs to perform for the test.
- **1** is the size in bytes of the RDMA WRITE.
- **0** is a flag specifying whether polling or event should be used. 0 signifies polling, and 1 signifies events.

Step 3 View the Latency results.

The following example is a display of the Latency test results:

```
Server Name: 192.168.0.1
Server Net Address: 192.168.0.1
         Connection Event: Received the correct event
Latency:     6.5 us
Latency:     6.5 us
Latency:     6.5 us
Latency:     6.5 us
Latency:     6.5 us
Latency:     6.5 us
Latency:     6.5 us
Latency:     6.5 us
Latency:     6.5 us
Latency:     6.5 us
Average latency:     6.5 us
         Connection Event: Received the correct event
closing IA...
Exiting program...
```

The notable performance value in the example above is Latency result that is 6.5 microseconds.

Compiling uDAPL Programs

This section provides information on how to compile uDAPL programs. Compiling uDAPL applications from source code requires use of the uDAPL header files and libraries included with the drivers.

Sample makefiles and C coder are in /usr/local/topspin/examples/dapl.

CHAPTER 7

MVAPICH MPI

The chapter describes MVAPICH MPI and includes the following sections:

Introduction

MPI is a standard library functionality in C, C++, and Fortran that is used to implement a message-passing program. MPI allows the coordination of a program running as multiple processes in a distributed memory environment.

This chapter includes setup and configuration information for the MVAPICH MPI. MVAPICH MPI supports both the GNU and Intel compiler suites. Each of these compiler suites, support the C, C++, Fortran77, and Fortran90 programming languages.

For additional details about MPI, go to the following URLs:

http://webct.ncsa.uiuc.edu:8900/public/MPI/

and

http://www.mpi-forum.org

For additional details about MVAPICH MPI, go to the following URL:

http://nowlab.cse.ohio-state.edu/projects/mpi-iba/

Note See the "Root and Non-root Conventions in Examples" section on page ix for details about the significance of prompts used in the examples in this chapter.

Initial Setup

This section describes the initial MPI setup. MPI can be used with either IPoIB or Ethernet IP addresses.

The drivers for MPI are automatically loaded at boot time if IPoIB or SDP is loaded. If neither IPoIB nor SRP are used, the MPI drivers can still be loaded at boot time. To enable loading MPI driver at boot time, run **chkconfig ts_mpi on**. The drivers for MPI can be loaded manually with **service ts_mpi start**.

MPI requires that you be able to launch executables on remote hosts without manually entering a login name, password, or passphrase. This procedure typically involves a one-time setup on one or more of the hosts that you want to use.

Although many technologies are available to meet this requirement, this chapter describes one method: how to set up SSH for password-less logins.

Configuring SSH

This section describes how to configure SSH. There are many ways to configure SSH to allow password-less logins. This section describes one way; your local policies or system administrators may advocate different ways. Any of them are sufficient as long as you can log in to remote nodes without manually entering a login name, password, or passphrase during the MPI run.

The example in this section distinguishes between passwords and passphrases. Passwords are associated with usernames and are normally used to log in and/or authenticate a user on a node. SSH can be configured to log in to remote nodes by using public key encryption to establish credentials on those nodes, making the use of passwords unnecessary. SSH keys can optionally be encrypted with passphrases, meaning that the keys cannot be accessed (and automated logins cannot be performed) without providing the proper passphrase, either by typing them in or caching them in a secure mechanism.

Because MPI requires fully automatic logins on remote nodes, typing of passphrases during the MPI run is disallowed. For simplicity, the text below describes how to set up SSH with a public key that uses no passphrase. Setting up SSH to use a cached passphrase is also permitted but is not described in this document.

Note The instructions in this section assume that you have never set up SSH before and have no existing public or private keys. Additionally, the instructions assume that you always launch MPI jobs from a single host (host1 in the following example). If you have already used SSH with key-based authentication, you should not use this procedure because it overwrites your existing keys.

To configure SSH, perform the following steps:

Step 1 Log in to the host that you want to configure as the local host, host1.

The following example shows how to log in to the host:

```
login: username
Password: password
host1$
```

Note Your exact login output is slightly different and could display information such as the day and the last time you logged in.

Step 2 Generate a public/private DSA key pair by entering the **ssh-keygen -t dsa** command. You are prompted for a folder in which to store the key.

The following example shows how to generate a public/private DSA key pair:

```
host1$ ssh-keygen -t dsa
Generating public/private dsa key pair.
Enter file in which to save the key (/home/username/.ssh/id_dsa):
```

Note In the above example, replace /home/username/ with the location of your home directory.

Step 3 Press the **Enter** key to store the key in the default directory.

The following example shows how to store the key in the default directory:

```
Enter file in which to save the key (/home/username/.ssh/id_rsa):
Created directory '/home/username/.ssh'.
Enter passphrase (empty for no passphrase):
```

Note If you have used SSH before, you may not see the created directory message as displayed in the example above.

Step 4 Press the **Return** key to create an empty passphrase. You will be prompted to reenter the passphrase. Press the **Return** key again.

Caution Do not enter a passphrase! This is because MPI requires fully automatic logins on remote nodes.

The following example shows how to create an empty passphrase:

```
Enter passphrase (empty for no passphrase): <hit Return>
Enter same passphrase again: <hit Return>
```

Upon success, a fingerprint of the generated key is displayed.

The following example shows the display of the fingerprint of the host:

```
Your identification has been saved in /home/username/.ssh/id_dsa.
Your public key has been saved in /home/username/.ssh/id_dsa.pub.
The key fingerprint is:
0b:3e:27:86:0d:17:a6:cb:45:94:fb:f6:ff:ca:a2:00
host1$
```

Step 5 Change into the .ssh directory that you created.

The following example shows how to change into the .ssh directory:

```
host1$ cd .ssh
```

Step 6 Copy the public key that was just generated to the authorized keys file.

The following example shows how to copy the public key to authorized keys file:

```
host1$ cp id_dsa.pub authorized_keys
host1$ chmod 0600 authorized_keys
```

Step 7 Test your SSH connection to host1. You should be able to establish an SSH session to host1 without being prompted for a username, password, or passphrase.

The following example shows how to verify that you can establish an SSH session to host1 without being prompted for a password or passphrase:

```
host1$ ssh host1 hostname
host1
host1$
```

Note If this is the first time that you have used SSH to log in to host1, you may see a message similar to the one below.

```
The authenticity of host 'host1 (10.0.0.1)' can't be established.
RSA key fingerprint is 6b:47:70:fb:6c:c1:a1:90:b9:30:93:75:c3:ee:a9:53.
Are you sure you want to continue connecting (yes/no)?
```

If you see this prompt, type **yes,** and press **Enter**. You may then see a message similar to this:

```
Warning: Permanently added 'host1' (RSA) to the list of known hosts.
```

You will see the host1 output next and are returned to a shell prompt. You should see this authentication message only the first time you use SSH to connect to a particular host. For example, if you run **ssh host1 hostname** again, you do not see the authentication message again.

Note If your home directory is shared between all nodes through a network file system, skip ahead to Step 10.

Step 8 Log in to another host that you want to use with MPI, host2. Create a .ssh directory in your home directory on host2 and set its permissions to 0700.

The following example shows how to create a .ssh directory in the root directory and set its permissions to 0700:

```
host2$ mkdir .ssh
host2$ chmod 0700 .ssh
```

Step 9 Return to host1 and copy the authorized keys file from Step 6 to the directory that you created in Step 8.

The following example shows how to return to host1 and copy the authorized keys file to the directory that was created:

```
host1$ scp authorized_keys host2:.ssh
```

Note If this is the first time you have logged in to host2 using SSH or SCP, you see an authenticity message for host2. Type **yes** to continue connecting. You do not see the message when connecting from host1 to host2 again.

Upon success, you see output similar to the following:

```
host1$ scp authorized_keys host2:.ssh
username@host1's password:
authorized_keys                               100% 2465     2.4KB/s   00:00
The user will need to enter their password at the "username@host1's password:"
prompt.authorized_keys                                100% 2465     2.4KB/s   00:00
```

Step 10 Test your SSH connection. You should be able to log in to the remote node without being prompted for a username, password, or passphrase.

The following example shows how to test your SSH connection:

```
host1$ ssh host2 hostname
host2
host1$
```

Step 11 Repeat Step 8 through Step 10 for each host that you want to use with MPI.

Note Clear all the authenticity messages before continuing to repeat the steps.

Editing Environment Variables

This section describes how to edit environment variables. You can more easily use MPI if you edit some environment variables based on the MPI implementation that you are using. This procedure allows you to run commands without typing long executable filenames. This section includes the three main methods:

- Setting Environment Variables in System-Wide Startup Files, page 7-6
- Editing Environment Variables in the Users Shell Startup Files, page 7-6
- Editing Environment Variables Manually, page 7-7

The following sections describe each of these methods.

Note Set up only one MPI implementation in the environment. Setting multiple MPI implementations simultaneously in the environment can cause unexpected results.

Setting Environment Variables in System-Wide Startup Files

This method is used to set a system-wide default for which MPI implementation is used. This method is the easiest for end users; users who log in automatically have MPI implementations set up for them without executing any special commands to find MPI executables, such as mpirun or mpicc. The example below describes how to set up MVAPICH in system-wide startup files.

The following example shows how to make two system-wide shell startup files (one for Bourne shell variants and one for C shell variants) that set up all users to use MVAPICH. These commands must be run by the superuser on all nodes where MPI is used:

```
host1# echo 'export PATH=/usr/local/topspin/mpi/mpich/bin:$PATH' > /etc/profile.d/mpi.sh
host1# echo 'set path = (/usr/local/topspin/mpi/mpich/bin $path)' > /etc/profile.d/mpi.csh
host1# chmod 755 /etc/profile.d/mpi.sh /etc/profile.d/mpi.csh
```

Editing Environment Variables in the Users Shell Startup Files

This method allows users to have their own preference of which MPI to use, but it requires that users manually modify their own shell startup files. Individual users can use this method to override the system default MPI implementation selection.

All shells have some type of script file that is executed at login time to set environment variables (such as PATH and LD_LIBRARY_PATH) and perform other environmental setup tasks. While your system may be different, Table 7-1 lists some common shells and the startup files that might require edits to set up MPI upon login.

Table 7-1 Common Shells and Startup Files

Shell	Startup File to Edit
sh (Bourne shell, or bash named sh)	$HOME/.profile
csh	$HOME/.cshrc
tcsh	$HOME/.tcshrc if it exists, or $HOME/.cshrc if it does not
bash	$HOME/.bashrc if it exists, or $HOME/.bash_profile if it exists, or $HOME/.profile if it exists (in that order)

The following example shows how to edit the shell startup files of a user to use MVAPICH. If the user uses the Bourne or Bash shell, edit the startup file after referring to Table 7-1 on all nodes where the user uses MPI, and add the following line:

```
export PATH=/usr/local/topspin/mpi/mpich/bin:$PATH
```

If the user uses the C or T shell, edit the startup file after referring to Table 7-1, and add the following line:

```
set path = (/usr/local/topspin/mpi/mpich/bin $path)
```

Editing Environment Variables Manually

Typically, you edit environment variables manually when it is necessary to run temporarily with a given MPI implementation. For example, when it is not desirable to change the default MPI implementation, you can edit the environment variables manually and set MVAPICH to be used for the shell where the variables are set.

The following example shows how to create a setup that uses MVAPICH in a single shell. If the user uses the Bourne or Bash shell, enter the following command:

```
host1$ export PATH=/usr/local/topspin/mpi/mpich/bin:$PATH
```

If the user uses the C or T shell, enter the following command:

```
host1$ set path = (/usr/local/topspin/mpi/mpich/bin $path)
```

MPI Bandwidth Test Performance

This section describes the MPI bandwidth test performance. The MPI bandwidth test is a good test to ensure that MPI and your installation is functioning properly. This procedure requires that you log in to remote nodes without a login name and password and that the MPI bin directory is in your PATH. To test MPI bandwidth, perform the following steps:

Step 1 Log in to your local host.

Step 2 Create a text file containing the names of two hosts on which to run the test. These hostnames are likely to be unique to your cluster. The first name should be the name of the host into which you are currently logged.

The following example shows one method to create a hostfile named hostfile that contains the hostnames host1 and host2:

```
host1$ cat > /tmp/hostfile <<EOF
> host1
> host2
> EOF
host1$
```

Step 3 Run the MPI bandwidth test across multiple hosts. Use the **mpirun** command to launch MPI jobs. The command uses these command-line parameters:

- The **-np** keyword to specify the number of processes
- The number of processes (an integer; use 2 for this test)
- The **–hostfile** keyword to specify a file containing the hosts on which to run
- The name of the hostfile
- The *bw* executable name

The following example shows how to run the MVAPICH MPI bandwidth test:

```
host1$ mpirun_rsh -np 2 -hostfile /tmp/hostfile /usr/local/topspin/mpi/mpich/bin/osu_bw
```

When the test completes successfully, you see output that is similar to the following:

```
# OSU MPI Bandwidth Test (Version 2.2)
# Size          Bandwidth (MB/s)
1               3.352541
2               6.701571
4               10.738255
8               20.703599
16              39.875389
32              75.128393
64              165.294592
128             307.507508
256             475.587808
512             672.716075
1024            829.044908
2048            932.896797
4096            1021.088303
8192            1089.791931
16384           1223.756784
32768           1305.416744
65536           1344.005127
131072          1360.208200
262144          1373.802207
524288          1372.083206
1048576         1375.068929
2097152         1377.907100
4194304         1379.956345
```

MPI Latency Test Performance

This section describes the MPI Latency test performance. The MPI Latency test is another good test to ensure that MPI and your installation are functioning properly. This procedure requires your ability to log in to remote nodes without a login name and password, and it requires that the MPI directory is in your PATH. To test MPI latency, perform the following steps:

Step 1 Log in to your local host.

Step 2 Create a text file containing the names of two hosts on which to run the test. These hostnames are likely to be unique to your cluster. The first name should be the name of the host where you are currently logged.

The following example shows one way to create a hostfile named *hostfile* that contains the hostnames host1 and host2:

```
host1$ cat > /tmp/hostfile <<EOF
> host1
> host2
> EOF
host1$
```

Step 3 Run the MPI Latency test across multiple hosts. Use the **mpirun** command to launch MPI jobs. The command uses these command-line parameters:

- The **-np** keyword to specify the number of processes
- The number of processes (an integer; use 2 for this test)
- The **–hostfile** keyword to specify a file containing the hosts on which to run

- The name of the hostfile
- The *latency* executable name

The following example shows how to run the MVAPICH MPI Latency test:

```
host1$ mpirun_rsh -np 2 -hostfile /tmp/hostfile \
/usr/local/topspin/mpi/mpich/bin/osu_latency
```

When the test completes successfully, you see output that is similar to the following:

```
# OSU MPI Latency Test (Version 2.2)
# Size          Latency (us)
0               2.83
1               2.85
2               2.86
4               2.94
8               2.97
16              2.97
32              3.08
64              3.11
128             3.90
256             4.26
512             4.95
1024            6.07
2048            7.31
4096            9.88
8192            23.35
16384           29.03
32768           41.23
65536           65.07
131072          113.01
262144          209.19
524288          400.72
1048576         780.69
2097152         1540.19
4194304         3072.65
```

Intel MPI Benchmarks (IMB) Test Performance

This section describes the IMB test performance. The IMB test executes a variety of communication patterns across multiple nodes as a simple stress test of your MPI and installation software. The tested patterns are as follows:

- PingPong and PingPing: tested across pairs of nodes
- Sendrecv, Exchange, Allreduce, Reduce, Reduce_scatter, Allgather, Allgatherv, Alltoall, Bcast, Barrier: tested across multiple nodes, always using a power of 2 such as 2, 4, 8, 16.

When your installation is not working properly, the IMB test might lead to VAPI_RETRY_EXEC errors. You should check the output of the PingPong, PingPing, and Sendrecv bandwidth measurements against known good results on similar architectures and devices. Low-bandwidth values, especially at high numbers of nodes, might indicate either severe congestion or functionality problems within the IB fabric. Congestion can occur when the IMB test is run across a large number of nodes on fabrics with a high-blocking factor. To test IMB benchmarks, perform the following steps:

Step 1 Download and compile the IMB test from the following URL:

http://www.intel.com/cd/software/products/asmo-na/eng/219848.htm

Step 2 Unpack the IMB test in $HOME.

Step 3 Compile the IMB test.

The following example shows how to compile the IMB test:

```
host1$ cd $HOME/IMB_3.0/src
host1$ make -f make_mpich MPI_HOME=/usr/local/topspin/mpi/mpich
```

Step 4 Log in to your local host.

Create a text file containing the names of all hosts on which to run the test. You should include at least two hosts. These hostnames are likely to be unique to your cluster. The first name should be the name of the host into which you are currently logged.

The following example shows one way to create a hostfile named hostfile that contains the hostnames host1 through host4:

```
host1$ cat > /tmp/hostfile <<EOF
> host1
> host2
> host3
> host4
> EOF
host1$
```

Step 5 Run the IMB tests across multiple hosts. Use the **mpirun** command to launch MPI jobs. The command uses these command-line parameters:

- The **-np** keyword to specify the number of processes
- The number of processes (an integer; use the number of hosts in the hostfile for this test)
- The **–hostfile** keyword to specify a file containing the hosts on which to run
- The name of the hostfile
- The IMB-MPI1 executable name

The following example shows how to perform the MVAPICH MPI IMB test by compiling and running IMB-MPI1 (vary the value of the *–np* parameter to reflect the number of hosts that you want to run):

```
host1$ /usr/local/topspin/mpi/mpich/bin/mpirun_rsh -np 2 -hostfile /tmp/hostfile \
$HOME/IMB_3.0/src/IMB-MPI1
```

When the test completes successfully, you see output similar to the following:

```
#---------------------------------------------------
#    Intel (R) MPI Benchmark Suite V2.3, MPI-1 part
#---------------------------------------------------
# Date       : Thu Oct 12 17:48:21 2006
# Machine    : x86_64# System     : Linux
# Release    : 2.6.9-42.ELsmp
# Version    : #1 SMP Wed Jul 12 23:32:02 EDT 2006
#
# Minimum message length in bytes:   0
# Maximum message length in bytes:   4194304
#
# MPI_Datatype                   :   MPI_BYTE
# MPI_Datatype for reductions    :   MPI_FLOAT
# MPI_Op                         :   MPI_SUM
#
# List of Benchmarks to run:

# PingPong
# PingPing
# Sendrecv
# Exchange
# Allreduce
# Reduce
# Reduce_scatter
# Allgather
# Allgatherv
# Alltoall
# Bcast
# Barrier

#---------------------------------------------------
# Benchmarking PingPong
# #processes = 2
#---------------------------------------------------
       #bytes #repetitions      t[usec]   Mbytes/sec
            0         1000         2.86         0.00
            1         1000         2.86         0.33
            2         1000         2.86         0.67
            4         1000         2.98         1.28
            8         1000         2.96         2.58
           16         1000         2.97         5.14
           32         1000         3.08         9.91
           64         1000         3.17        19.27
          128         1000         3.95        30.87
          256         1000         4.28        57.03
          512         1000         5.03        97.08
         1024         1000         6.15       158.89
         2048         1000         7.51       259.97
         4096         1000        10.26       380.71
         8192         1000        22.93       340.73
        16384         1000        29.34       532.59
        32768         1000        41.80       747.56
        65536          640        66.16       944.69
       131072          320       114.53      1091.41
       262144          160       214.48      1165.64
       524288           80       405.76      1232.25
      1048576           40       792.88      1261.23
      2097152           20      1570.12      1273.78
      4194304           10      3113.90      1284.56
<output truncated>
```

Compiling MPI Programs

This section describes how to compile MPI programs. Compiling MPI applications from source code requires adding several compiler and linker flags. MVAPICH MPI provides *wrapper* compilers that add all appropriate compiler and linker flags to the command line and then invoke the appropriate underlying compiler, such as the GNU or Intel compilers, to actually perform the compile and/or link. This section also provides examples of how to use the wrapper compilers. To compile MPI programs, perform the following steps:

Step 1 Log in to your local host.

Step 2 Copy the example files to your $HOME directory.

The example files can be copied as follows:

```
host1$ cp -r /usr/local/topspin/mpi/examples $HOME/mpi/mpich/src/examples/hello
```

The files in the /usr/local/topspin/mpi/examples directory are sample MPI applications that are provided both as a trivial primer to MPI as well as simple tests to ensure that your MPI installation works properly. There are two MPI examples in the directory, each in four programming languages.

The following example shows Hello world:

C	hello_c.c
C++	hello_cxx.cc
F77	hello_f77.f
F90	hello_f90.f90

The following example sends a trivial message around in a ring:

C	ring_c.c
C++	ring_cxx.cc
F77	ring_f77.f
F90	ring_f90.f90

Note A comprehensive MPI tutorial is available at the following URL:

http://webct.ncsa.uiuc.edu:8900/public/MPI/

Step 3 Select the language and compiler of your choice from the selection of compiler wrappers available in Table 7-2.

Table 7-2 Selecting Language and Compiler Wrappers

Language	Compiler		
	GNU	Intel	PGI
C	mpicc	mpicc.i	not applicable
C++	mpiCC	mpiCC.i	not applicable
Fortran 77	mpif77	mpif77.i	mpif77.p
Fortran 90	not applicable	mpif90.i	mpif90.p

Step 4 Compile the examples as shown here:

```
host1$ cd $HOME/mpi-examples
host1$ mpicc.i -o hello_c hello_c.c
host1$ mpiCC.i -o hello_cxx hello_cxx.cc
host1$ mpif77.i -o hello_f77 hello_f77.f
host1$ mpif90.i -o hello_f90 hello_f90.f90
```

Note The example above uses the Intel compiler. Change the command names as listed in Table 7-2 if you are using the GNU or the PGI compiler.

Step 5 If the $HOME/mpi-examples directory is not shared across all hosts in the cluster, copy the executables to a directory that is shared across all hosts, such as to a directory on a network file system.

Step 6 Run the MPI program.

The following example shows how to run an MVAPICH MPI C program Hello World:

```
host1$ mpirun_rsh -np 2 -hostfile /tmp/hostfile $HOME/mpi-examples/hello_c
Hello, world, I am 0 of 2
Hello, world, I am 1 of 2
```

CHAPTER 8

HCA Utilities and Diagnostics

This chapter describes the HCA utilities and diagnostics and includes the following sections:

Introduction

The sections in this chapter discuss HCA utilities and diagnostics. These features address basic usability and provide starting points for troubleshooting.

Note See the "Root and Non-root Conventions in Examples" section on page ix for details about the significance of prompts used in the examples in this chapter.

hca_self_test Utility

This section describes the hca_self_test utility. The hca_self_test utility displays basic HCA attributes and provides introductory troubleshooting information. To run this utility, perform the following steps:

Step 1 Log in to your host.

Step 2 Run the **hca_self_test** command.

The following example shows how to run the **hca_self_test** command:

```
host1# /usr/local/topspin/sbin/hca_self_test
rhel4-2.6.9-42.ELsmp-3.2.0-136
---- Performing InfiniBand HCA Self Test ----
Number of HCAs Detected ................ 1
PCI Device Check ....................... PASS
Kernel Arch ............................ x86_64
Host Driver Version .................... rhel4-2.6.9-34.ELsmp-3.2.0-136
Host Driver RPM Check .................. PASS
HCA Type of HCA #0 ..................... LionMini
HCA Firmware on HCA #0 ................. v5.2.000 build 3.2.0.136 HCA.LionMini.A0
HCA Firmware Check on HCA #0 ........... PASS
```

```
Host Driver Initialization ............. PASS
Number of HCA Ports Active ............. 2
Port State of Port #0 on HCA #0 ........ UP 4X
Port State of Port #1 on HCA #0 ........ UP 4X
Error Counter Check on HCA #0 .......... PASS
Kernel Syslog Check .................... PASS
Node GUID .............................. 00:05:ad:00:00:20:08:48
------------------ DONE ---------------------
```

Table 8-1 lists and describes the fields in the **hca_self_test** output.

Table 8-1 Fields in hca_self_test Output

Field	Description
Number of HCAs Detected	Number of HCAs on the host that the test recognizes.
PCI Device Check	Confirms that HCA shows up correctly as a PCI device.
Kernel Architecture	Kernel architecture on the host.
Host Driver Version	Version of the drivers on the host.
Host Driver RPM Check	Confirms that the RPMs that are installed are compatible with the host operating system.
HCA Type of HCA #0	Displays the HCA card type.
HCA Firmware on HCA #0	Firmware version that runs on the HCA.
HCA Firmware Check on HCA #0	Displays PASS or FAIL.
Host Driver Initialization	Confirms that the IPoIB driver is installed correctly.
Number of HCA Ports Active	Number of enabled ports on the HCA.
Port State of Port #0 on HCA #0	Displays up or down to reflect the status of the port.
Port State of Port #1 on HCA #0	Displays up or down to reflect the status of the port.
Error Counter Check	Displays PASS or FAIL.
Kernel Syslog Check	Displays PASS or FAIL.
Node GUID	IB node GUID.

tvflash Utility

This section describes the tvflash utility and includes the following topics:

Note The firmware upgrade is handled automatically by the installation script. You should not have to upgrade the firmware manually. For more information about the installation script, see Chapter 2, "Installing Host Drivers."

Viewing Card Type and Firmware Version

To display the type of HCA in your host and the firmware that it runs, perform the following steps:

Step 1 Log in to your host.

Step 2 Enter the **tvflash** command with the **-i** flag.

The following example shows how to enter the **tvflash** command with the **-i** flag:

```
host1# /usr/local/topspin/sbin/tvflash -i
HCA #0: MT25208 Tavor Compat, Lion Cub, revision A0
  Primary image is v4.8.200 build 3.2.0.136, with label 'HCA.LionCub.A0'
  Secondary image is v4.7.400 build 3.2.0.118, with label 'HCA.LionCub.A0'

  Vital Product Data
    Product Name: Lion cub
    P/N: 99-00026-01
    E/C: Rev: B03
    S/N: TS0520X01634
    Freq/Power: PW=10W;PCIe 8X
    Date Code: 0520
    Checksum: Ok
```

The firmware that runs on the HCA appears in the Primary image line displayed in Step 2. The card type also appears in this line as one of the following:

- PCI-X Cougar
- PCI-X Cougar Cub
- PCI-e Lion Cub
- PCI-e Lion Mini
- PCI-e Cheetah
- PCI-e CheetahDDR

The ASIC version appears as A1 or A0.

Upgrading Firmware

To upgrade firmware on your host, perform the following steps:

Note Upon installation of the host drivers, the firmware is automatically updated, if required. However, if you have outdated firmware on a previously installed HCA, you can upgrade the firmware manually.

Step 1 Log in to your host, and flash the updated firmware binary to your local device. The firmware images are at /usr/local/topspin/share.

Step 2 Enter the **/usr/local/topspin/sbin/tvflash** command with the following information:

- The **-h** flag
- The number of the HCA in the host (0 or 1 on hosts that support 2 HCAs)
- The firmware binary file (including path)

The following example shows how to use the **tvflash** command:

```
host1# tvflash -h 0 /usr/local/topspin/share/fw-lioncub-a0-4.8.200.bin
New Node  GUID = 0005ad020021700c
New Port1 GUID = 0005ad020021700d
New Port2 GUID = 0005ad020021700e
Programming HCA firmware... Flash Image Size = 325696
Flashing - EFFFFFFFEPPPPPPPPEWWWWWWWEWWWWWWWWEWWWVVVVVVVVVVVVVVVVVVVVVVVVVVVVV
Flash verify passed!
```

When flashing the new firmware, the display shows an output string similar to the one in the example above. The meaning of the letters displayed are as follows:

E = Erase

I = Writing Invariant (not failsafe, rare)

F = Writing Failsafe

P = Writing Primary Pointer Sector

W = Writing Firmware

V = Verify Firmware

Note Reboot your host after flashing the new firmware.

Diagnostics

This section includes diagnostics information. A few diagnostic programs are included with the Linux IB host drivers.

The vstat utility prints IB information.

The following example shows a vstat utility display:

```
host1# /usr/local/topspin/bin/vstat
1 HCA found:
        hca_id=InfiniHost0
        pci_location={BUS=0x07,DEV/FUNC=0x00}
        vendor_id=0x02C9
        vendor_part_id=0x6278
        hw_ver=0x20
        fw_ver=0x400070258
        PSID=
        num_phys_ports=2
                port=1
                port_state=PORT_ACTIVE
                sm_lid=0x0003
                port_lid=0x0006
                port_lmc=0x00
                max_mtu=2048

                port=2
                port_state=PORT_ACTIVE
                sm_lid=0x0003
                port_lid=0x000b
                port_lmc=0x00
                max_mtu=2048
```

There are also several files in /proc/topspin that contain diagnostic information.

The following are examples of diagnostic files:

```
host1# cat /proc/topspin/core/ca1/info
name:          InfiniHost0
provider:      tavor
node GUID:     0005:ad00:0005:00f0
ports:         2
vendor ID:     0x2c9
device ID:     0x6278
HW revision:   0x20
FW revision:   0x400070258
PCIe width:    x8

host1# cat /proc/topspin/core/ca1/port1/info
state:         ACTIVE
link:          4X
LID:           0x0006
LMC:           0x0000
SM LID:        0x0003
SM SL:         0x0000
Capabilities:  IsTrapSupported
               IsAutomaticMigrationSupported
               IsSLMappingSupported
               IsLEDInfoSupported
               IsSystemImageGUIDSupported
               IsVendorClassSupported
               IsCapabilityMaskNoticeSupported
```

APPENDIX A

Acronyms and Abbreviations

Table A-1 defines the acronyms and abbreviations that are used in this guide.

Table A-1 List of Acronyms and Abbreviations

Acronym	Expansion
API	Application Program Interface
CLI	command-line interface
GUI	graphical user interface
GUID	globally unique identifier
HCA	Host Channel Adapter
IB	InfiniBand
IPoIB	Internet Protocol over InfiniBand
ITL	Initiator/Target/LUN
LU	logical unit
LUN	logical unit number
MPI	Message Passing Interface
MVAPICH MPI	MVAPICH Message Passing Interface
OFED	OpenFabrics Enterprise Distribution
Open MPI	Open Message Passing Interface
PCU	protocol control information
RAID	Redundant Array of Independent Disks
RDMA	Remote Direct Memory Access
RPM	Red Hat Package Manager
SAN	Storage Area Network
SCP	Secure Copy
SCSI	Small Computer System Interface
SDP	Sockets Direct Protocol
SFS	Server Fabric Switching
SRP	SCSI RDMA Protocol

Table A-1 List of Acronyms and Abbreviations (continued)

Acronym	Expansion
SSH	Secure Shell Protocol
TCP	Transmission Control Protocol
uDAPL	User Direct Access Programming Library
ULP	upper-level protocol
WWNN	world-wide node name
WWPN	world-wide port name

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